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THE DEVELOPMENT OF A PROCEDURE FOR EVALUATION OF THE HAZARD POTENTIAL OF INDUSTRIAL OPERATIONS

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SUMMARY

Safety engineering has long labored under the assumption that the worker, and not the situation, is the cause of most serious industrial accidents. Only in recent years, has any serious attention been paid to the part played by the hazards that are inherent in an operation. Even less work has been done in any attempt to measure these hazards and determine their injury causing potential. In this study, a method was developed by which the safety engineer could use his historical accident data to evolve a hazard rating plan, capable of evaluating the hazard potential of an operation.

The procedure used in developing the Hazard Potential Rating Form is relatively simple and is dependent upon the data that is present in the files of any industrial safety department. Both the per cent contribution of a hazard to the overall injury rate and the average cost per accident due to that element are considered in the final analysis. These two indicators of accident importance have been balanced with each other to be used in applying weights to the individual hazard that is being considered. The completed rating form is the collection of all relevant hazards and is comparable in form to the job evaluation point rating evaluation sheet used by many companies. An example rating form has been developed, using sample data, to demonstrate the procedure used to arrive at the final evaluation form. This method can be used to develop a comparable rating plan for any number of hazard elements that are felt to be significant.

CHAPTER I

OBJECTIVES

The primary objective in using the Hazard Potential Rating Form is to provide an objective basis by which one operation can be compared to another as to its potential for causing serious injury. The result of each individual evaluation will be a point rating which can be used in such a comparison. The results of such evaluation will be used to direct the attention of the safety engineer to those areas which have the greatest potential for causing a serious accident, thus providing a basis for selective accident preventive efforts. The situation can then be corrected, if possible, and a re-evaluation would then be instituted. This review can be performed for all the operations under consideration at established intervals, or done immediately after a modification of an operation is made and limited to only the modified operation. In this manner, it will be possible to keep a current record of priorities for safety efforts.

A secondary objective is to acquaint the safety engineer with the relative importance of each type of hazard in the company for which he is working. He can also learn the contribution of each specific hazard to the overall accident cost figures. This is important knowledge in any accident cost control program instituted by the safety department.

CHAPTER II

INTRODUCTION

The field of safety engineering has long been in need of an objective procedure by which the injury causing potential of an operation could be measured. Most safety engineers rely largely on the past accident performance of a job to point out its injury causing possibilities. This type of evaluation often results in the engineer spending more of his time analyzing past accident records, than in trying to prevent future cases from occurring. In some cases, the methods have been altered so that past accident records are of little use in predicting future performance. The proposed procedure contained in this paper has been devised to force the safety engineer into a preventive posture that is attuned to analytical, rather than reportive safety engineering.

Hazard analysis, in the past, depended largely upon the historical analysis of data. In recent years, several leading researchers in the field have tried to introduce more scientific methods of hazard evaluation. However, none of these methods has substantially reduced the subjectivity in the analyses. Many of the newest methods use random sampling techniques which are claimed to introduce objectivity into the procedure. Nevertheless, these methods usually allow for wide variations in rater interpretation as to what constitutes unsafe acts. The field of work measurement has proven the weaknesses of allowing individual interpretations of situations. However, even these weaknesses could be greatly reduced by rating the operation and not the worker. Most of these proposed sampling plans have based their data on the unsafe acts of the worker and not the operation. If the reverse were done, more objective results could be obtained, since the standardization of terms could be much more easily achieved.

The purpose of the proposed research is to develop an evaluation plan that will rate the operation, not the worker, as to its hazard potential. It will be assumed that the worker has been properly trained and is aware of any safety precautions that have been specified by the methods engineers. Unsafe acts by the worker will not be considered. It is felt that proper training and effective supervision is more important in this area of accident control. The major purpose of the Hazard Potential Rating Procedure will be to minimize any situations that are inherent in the operation and could lead to a serious injury. Minor injuries and first-aid cases will also be assumed to lie outside the scope of the proposed method.

CHAPTER III

LITERATURE SURVEY

An objective and reliable method of determining the hazard potential of an operation is of prime importance to the safety engineer. All too often the management of a company accepts a certain level of accidents as inevitable, not realizing that many of these accidents could have been avoided had the proper tools been made available to the safety engineer. H. J. Kolodner states that a disabling injury occurs every three seconds in this country, with a death occurring every five minutes (1). Although one is often able to accurately determine the direct costs of these accidents, this does not provide a reliable measure of their actual value. It has been repeatedly shown that the hidden, or indirect, costs of an accident can be three to seven times more than the direct costs. If this is the situation, then when management states that it can accept a certain level of accidents, it is actually accepting several times this level in many cases. An accurate method of determining the hazard potential of an operation is, therefore, required in order to be able to focus the attention of the safety engineer on the areas where the most improvement can be realized.

There are three distinct methods of evaluating the hazard potential of an operation in use at the present time. The most frequently used method considers the historical accident record of a particular operation. The second of the methods used to determine the possibility of an accident is concerned primarily with the use of subjective evaluations. The last method proposes that random sampling be used, and has been used only sparingly in the past few years. The random sampling method has been suggested to be the most scientific of the three methods in use.

The historical analysis of data seems to be the most popular method used for the measurement of hazard potential at the present time. John L. Pickens suggests that one of the primary purposes of the safety engineer should be to establish an efficient procedure for determination of danger areas after an accident or near miss (2). This method, however, has its major disadvantage in that it forces the safety engineer into a backward, instead of forward, looking attitude. There have been recent attempts at using historical data that have attempted to diminish this drawback. Two of these methods are the "Critical Incident Technique" by H. J. Kolodner (3) and "High Potential Accident Analysis" by William W. Allison (4). Both of these methods attempt to analyze a problem area before it produces a serious accident. Again, however, they both tend to foster the identical backward looking attitude encountered in the earlier methods. Another major disadvantage of the historical method is the fact that it is totally worthless in the analysis of a new or revised operation. In the fast changing environment of modern industry, an a priori method of evaluation is required for effective safety engineering.

There have been several attempts made to determine a method by which a safety engineer could evaluate a potentially hazardous activity before it developed. A. D. Swain has proposed that evaluation should begin in the design stage of an operation (5). One should attempt to design the operation to be as safe as possible by having a qualified safety engineer review the planning of a new operation. There would then be periodic follow-up inspections to determine if any hazardous conditions have developed after implementation. The suggestion is made that it is more important to concentrate the effort on accident prone operation and not on accident prone people, since the operation is the basic cause of most accidents. There is a disadvantage in this method, however, in that there are no actual objective ratings that can be applied to these operations that actually demonstrate the hazard potential that is present.

Robert E. McEldowney Jr. has proposed a method by which historical data is supplemented by subjective evaluations (6). This method is termed the "Job Hazard Study." It compares and relates the past history of each operation with evaluations presented by the responsible supervisor and workers. This method, which uses subjective evaluations by untrained personnel, allows no objective comparisons to be made among differing situations. As of this date no actual objective method of rating hazardous potential has been evolved.

Random sampling to determine the accident potential of an operation is relatively new approach and has yet to prove itself as a reliable indicator of hazard potential. Regal C. Meier, of the Chrysler Corporation, has developed a complex sampling system which has helped to reduce the accident level of his company (7). It involves random sampling tours by specially trained safety personnel. In all there are seventy specific types of hazards that are to be looked for during the tour. It also records the number of workers that are performing safely as compared to those involved in unsafe acts. As impressive as this method seems to be, it still involves the concept of one person deciding what is and what is not an unsafe act. Also, it presupposes that the major cause of accidents lies with the worker and not with the actual operation itself. Although it introduces objectivity into the analysis, it still remains that it does not actually rate the hazard potential of the operation.

CHAPTER IV

PROPOSED METHOD

In order to accurately determine the hazard potential of a work situation, one must first define the exact causes that could lead to an accident. Since each individual industry differs widely in its production methods, these causes will vary in their relative importance from company to company. In this study, all accident data has been taken from the industrial safety records accumulated and published by the National Safety Council (8). These figures are not meant to be representative of any particular industry, but are used solely for the purpose of illustration in the development of the proposed procedure. It is expected that the results that are obtained from this study will apply only to those elements of hazard that are common from one industry to another. Such elements might possibly be manual movements and simple hand tool operations. However, when specialized operations are being considered, it is recommended that the company involved perform its own investigations to determine the hazards to be included and relevant data as to each hazard that is chosen.

The following is an overall view of the proposed procedure. The individual steps will be further explained in subsequent sections of this paper. The initial step in the development of the Hazard Potential Rating Procedure is the determination of precisely what hazards should be included in the study. Once these elements have been selected they should be strictly defined in order to avoid repetition and overlap. When the definition stage has been completed, the accumulation of the relevant data needed in the study may then proceed. The data that is collected is then analyzed to determine the importance of each type of hazard with reference to its cost to the company. This step is of great importance, since it will determine the weight attached to that element in the final evaluation form. All that remains to be done is the differentiation of each hazard into appropriate degrees, following the same procedure as used in establishing a job evaluation point rating system. These degrees of hazard should be adequately defined and sufficiently clear to prevent confusion over the semantics by the rating individual. Combining these hazards elements and arranging them into an order of importance completes the development of the rating form.

The actual development of a sample rating form will now be reviewed. All relevant hazards will be included to illustrate the overall development of the method. However, only one hazard, the manual handling of objects, will be used to illustrate minor or intermediate stages in the development of the proposed method. This is being done in the interest of clarification and it should be understood that all of the other elements of hazard will be handled in a similar manner.

I. Selection of Relevant Hazards

It is necessary that all hazards that could possibly cause any appreciable number of serious accidents be included in the study. This will, of course, be left to the discretion of the individual safety engineer involved, however this individual should have his study checked by an associate in order to verify the fact that every possible hazardous condition has been taken into consideration. The historical records of the safety department is the most important source of information for the identification of such hazardous conditions. Questionnaires sent to supervisory personnel can also be helpful in detecting possible causes of accidents, especially those that are present, but have not yet resulted in a serious accident. It is preferable to include seemingly unimportant elements in the initial stages of the procedure to avoid overlooking one or more elements at this time. Elements can always be dropped with little penalty as the study progresses and as their lack of significance is displayed.

For the purpose of illustration, nine major elements of hazard will be included in the development of the proposed evaluation form. It is felt that these elements are common to most industrial enterprises, and the findings of the National Safety Council seem to substantiate this decision.

The nine major sources of accidents that were selected are as follows:

I. Handling Objects

   1. Manual
   2. Mechanical

II. Falls

   1. Same Level
   2. Different Levels

III. Struck by Falling, Moving Object

IV. Machinery in Motion

V. Bumping into Objects

VI. Use of Hand Tools

VII. Electrical, Heat, Explosive Dangers

VIII. Danger from Harmful Substances

IX. Elevator, Hoist, Conveyor Dangers.

As stated previously, these elements should not be assumed to be all inclusive. However, within the scope of this development, they will be considered as the sole contributors of all serious accidents.

II. Definition of Elements

A complete definition for each of the elements chosen is essential. It prevents confusion from arising among the personnel who will be called upon to perform the evaluation. A complete definition is also required for the accumulation of the required data. Since most companies do not file accident reports strictly according to the cause involved, it is essential for the researcher to be able to correlate those reports with the hazard elements that have been selected for the study. Ambiguous definitions at this time could greatly affect the application of the weighting factor later in the analysis.

The definitions, themselves, should not be the work of merely one individual. Consultations should be arranged between the safety personnel, line supervisors, and, if necessary, with the workers in order to form a complete picture of all the ramifications of the particular hazard under consideration. After all the individual hazard elements have been defined, they should then be reviewed in their entirety so as to eliminate any possible overlap or repetition. An example of the proposed type of definition might prove helpful at this time.

> def Manual Movement of Materials
>
> movement of materials performed by the operator during the normal course of the job without mechanical aids will be considered as manual movement of material. This movement might be incurred either directly or indirectly by the worker. The movement shall be performed by the operator without the use of any mechanically operated handling equipment. The hazard must be presented directly by the material being moved and the consequences of making the move with the material. This excludes any hazard that might be present had the same action been performed without any material movement.

Several facets of the preceeding definition should be further commented upon. The exclusion of handling aids should eliminate any possibility of overlap with both the hand tools and the mechanical handling elements that have been chosen. Also, if the hazard were present without the material being moved, it would more properly fall under the classification of an obstruction hazard which would belong elsewhere. As many exclusions as are necessary should be added to the definition in order to prevent any possible repetition.

III. Accumulation of Data

The third stage in the development of the proposed evaluation form consists of the accumulation of data for the hazard elements chosen for the study. The required data exists in two forms. The first step is to assign a percentage contribution factor to each element. This factor denotes the percentage of the overall accident level that is contributed by that element. This information can usually be obtained from the accident history files of the safety department in the company. In the case of a new, or revised, operation the required information can be obtained by estimation or comparison with similar operations within the industry. If it is necessary to estimate the element's contribution, it should be done carefully and after considerable research.

The second type of data that is needed is the average cost per accident that results from the given hazard element. The average cost per accident figure is used in order to lend weight to those types of accidents that result in the most costly injuries. Every element of hazard has certain types of injuries that are common to it. The costs of these differing types of injuries can vary widely. This average cost figure should be based on as large a sample population as is possible. The figures published by a national or industry-wide agency should be used whenever possible. However, care should be taken to insure that the elements used in the study are comparable to those used by the publishing agency.

Table 1 contains the percentage contribution factors and the average cost per case figures for the elements used in this paper. Wherever possible these figures should be obtained separately for the permanent total, permanent partial, and the temporary total disability cases. This will allow more emphasis to be placed upon those elements that might lead to the most serious injuries. A hazard that produces accidents with a predominance of permanent total disability cases is more in need of correction than one with a history of causing less serious injuries. The same evaluation procedure could be carried out using the overall accident figures, however, it would tend to over-emphasize the hazards that have a low to medium total cost contribution.

IV. Determination of Relative Severity

The relative severity of a hazard element is the average cost per case figure for a disability classification as compared to the average cost per case figure for a temporary total disability. In addition to simplifying the data, this results in further emphasizing the importance that must be placed on those hazards that cause the most serious injuries. It also minimizes the importance of a minor disability when compared to a major disability. Table 2 illustrates the results that were obtained using the data available for this study.

Several observations should be made about the results observed in Table 2. The lower the value for a particular element under the permanent total disability column, the less emphasis should be placed

Table 1. Per Cent Contribution and Average

Cost per Accident Data

Source of Injury	Perm. Per cent Contri-bution	Total Cost	Perm. Per cent Contri-bution	Part. Cost	Temp. Per cent Contri-bution	Total Cost
Handling Objects						
1. Manual	13.9	$15,351	9.6	$1,595	28.5	$348
2. Mechanical	18.0	14,304	4.3	2,298	5.2	389
Falls						
1. Same Level	4.8	14,466	9.2	1,950	11.0	331
2. Different Level	12.6	13,394	9.3	3,118	10.2	493
Struck by Falling Moving Object	9.3	12,373	19.3	1,1039	11.1	300
Moving Machinery	3.1	18,538	19.2	1,353	6.3	230
Bumping into Objects	2.3	16,888	5.6	691	7.6	154
Hand Tools	1.5	15,596	8.1	1,012	5.3	241
Elec., Heat Explos.	7.7	12,766	2.2	1,474	2.6	241
Harmful Substances	8.2	14,515	1.1	2,074	3.0	456
Elevators, Hoists Conveyors	3.6	13,965	3.8	1,986	1.5	425

Source: Accident Facts, National Safety Council, 1964.

Table 2. Determination of the Relative Severity for each Hazard

Source of Injury	Perm. Tot.	Perm. Part.	Temp. Tot.
Handling Objects	39.5	4.5	1
Falls			
1. Same Level	44.0	6.1	1
2. Different Level	27.0	6.3	1
Struck by Falling Moving Object	41.0	3.3	1
Moving Machinery	81.0	6.2	1
Bumping into Objects	109.0	4.5	1
Hand Tools	65.0	4.4	1
Elect., Heat, Explosive	53.0	6.0	1
Harmful Substances	32.0	4.5	1
Elevators, Hoists, Conveyors	31.0	4.6	1

on differentiating between the three classifications of injuries for the element concerned. The number 109, which is the relative severity of a permanent total disability for the element "Bumping into Objects," shows a great predominance of serious injuries as compared to less serious injuries due to this type of hazard. An extensive analysis of this type using the relative severity rates can, in itself, provide a valuable aid to the safety engineer. It can point out the hazards that should be concentrated upon in order to reduce the total accident cost level.

V. Adjustment of Relative Severity

In this stage of the procedure the two types of data, the percentage contribution factors and the average cost figures, are combined to provide a measure of comparison between the individual elements. The relative severity figures of Table 2 are multiplied by their respective percentage contribution factors. The resulting number will be known as the adjusted relative severity of that element. These adjusted rates are summarized in Table 3. This process is performed in order to smooth the elements so that neither the percentage contribution nor the cost dominates the final evaluation analysis. In this manner both the cost and the number of injuries are taken into account. Using either of these factors alone would tend to bias the evaluation toward certain, different elements. This type of development allows the greatest emphasis to be placed on the elements leading to the most serious injuries, and yet, it still takes into account the case where a large number of less serious injuries might suggest

Table 3. The Adjusted Relative Severity
for Each Hazard

Hazard Element	Perm. Tot.	Perm. Par.	Temp. Tot.	Total
Handling Objects				
1. Manual	560	43.2	28.5	631
Falls				
1. Same Level	211	54.0	11.0	276
2. Different Level	351	59.0	10.2	420
Struck by Falling Moving Object	381	64.0	11.1	456
Moving Machinery	243	119	6.3	368
Bumping into Objects	250	25.0	7.6	282
Hand Tools	97	36.0	5.3	138
Elect., Heat, Expl.	408	13.0	2.6	423
Harmful Substances	262	5.0	3.0	270
Elev., Hoists, Conv.	111	17.0	2.6	130

a higher weight for that element in the final analysis.

The individual adjusted severity rates for the permanent total, permanent partial, and the temporary total cases are then totalled for each hazard element. This action produces the overall adjusted severity figure for that element, which can be used in comparing its importance with any other element. It is this number that will be used in the assignment of the weights that occurs in the following stage of the procedure.

VI. Assignment of Weights to Elements

The weight that is applied to a particular element is dependent upon that element's overall adjusted severity figure. The determination of the numerical ranges to be used to determine the weights is purely arbitrary and dependent upon the values that are being used in the study. The range also depends upon the number of degrees of hazard potential that are desired to be present in the final evaluation form. In the development of the study now being used the overall relative severity rates ranged from zero to 631. In addition, it was decided that a scale consisting of five degrees was desired for the evaluation. The basic scale consists of the numbers zero through four. These numbers are then multiplied by the appropriate weighting factor for each element dependent upon the overall severity factor for that element. The following scheme is used in determining the weighting factor that is to be applied.

Overall Relative Severity	Weighting Factor
0-140	x1
141-280	x2
281-420	x3
421-560	x4
561 or greater	x5

The use of the above weighting scheme allows all the overall adjusted severity rates to be equalized. Each element retains its relative importance to all other elements throughout the five degrees chosen for the final evaluation form. Multiplying each number of the basic set by the appropriate weighting factor results in the maximum number of points for each of the five degrees of hazard potential for a given element. The elements chosen for this study result in the weights shown in Table 4. It will be noticed that there is little difference among the elements at low levels of hazard, with increasing differences as the level of the hazard rises. This allows more emphasis to be placed on the high danger areas that might result in the most serious and costliest injuries.

VII. Definition of Degrees

For the safety engineer to be able to assign the correct rating points to a particular hazard, it is necessary that there be clear distinctions drawn among the five degrees employed for each hazard element. Some evaluation procedures use a comparison method, where the rater uses benchmark operations to make the decisions on points to be assigned. This method is felt to be inappropriate in the present

Table 4. Weighting Factors to be Applied to each Hazard Element

Hazard Element	Weighting Factor	Point Range
Handling Objects		
1. Manual	x5	0 5 10 15 20
2. Mechanical	x5	0 5 10 15 20
Falls		
1. Same Level	x2	0 2 4 6 8
2. Different Level	x3	0 3 6 9 12
Struck by Falling Moving Object	x4	0 4 8 12 16
Moving Machinery	x3	0 3 6 9 12
Bumping into Objects	x2	0 2 4 6 8
Hand Tools	x1	0 1 2 3 4
Elect., Heat, Expl.	x3	0 3 6 9 12
Harmful Substances	x2	0 2 4 6 8
Elev., Hoists, Conv.	x1	0 1 2 3 4

situation. In its place will be a series of statements or definitions about the hazard that will be used as indicators of hazard potential. The form of these statements will depend upon the situation that is being considered. The degree definitions that have been selected for the proposed procedure under study might not be applicable under a different situation. However, once the factors have been chosen, it is important that they be held constant, otherwise, a completely new evaluation of all operations would have to be made.

The selection of these degree definitions introduces subjectivity into the analysis. In order to diminish the effect of this subjectivity, group planning should be used to arrive at the results. The safety department can work with the supervisory personnel in determining the form and substance of these definitions. An example of the type of definition required for the form is given below. The complete set of degree definitions for all elements is presented in the appendix. The column entitled "max. pts." refers to the maximum number of rating points that can be assigned to that degree of hazard by the rating individual.

I. Handling Objects	Max. Pts.
1. Manual	
a. Minimum of manual handling required of operation.	0
b. Infrequent handling outside line of normal duty.	5

c. Intermittant handling operations necessary to work progress. 10

d. Frequent manual movement of heavy or bulky loads. 15

e. Continuous movement of heavy or bulky material. 20

Once all degrees have been defined, it is but a simple matter to arrange all of the hazard elements into the completed Hazard Potential Rating Form. The evaluation form should include a section that can be used by the rating individual for identification of the exact operation that is being rated and for any other information that is felt to be necessary. It is advisable to add as many identification blanks as are necessary to fully specify the operation under study. Otherwise, confusion may arise, especially in the case of a large shop where many similar operations are performed.

The evaluation form for the data used in this development is displayed in Table 5. It should again be said that this form is applicable only to the data and elements that were used in the development contained herein. The weights that were used to arrive at the proper maximum point values are only correct for the historical data used to develop the present method. They would have to be altered in the case of any significant change in either the elements used or the data collected. In any case, the method used to arrive at the completed evaluation form would remain the same as has been proposed.

Table 5. Completed Hazard Potential Rating Form

	First Degree	Max. Pts.	Second Degree	Maximum Pts.	Third Degree	Max. Pts.	Fourth Degree	Max. Pts.	Fifth Degree	Max. Pts.	Rating Points
Handling Objects											
Manual		0		5		10		15		20	
Mechanical		0		5		10		15		20	
Falls											
Same Level		0		2		4		6		8	
Diff. Level		0		3		6		9		12	
Fall., Mov. Obj.		0		4		8		12		16	
Machinery		0		3		6		9		12	
Bumping into Obj.		0		2		4		6		8	
Hand Tools		0		1		2		3		4	
Elec., Heat, Expl.		0		3		6		9		12	
Harmful Substances		0		2		4		6		8	
Elev., Hoists, Con.		0		1		2		3		4	

Total Hazard Rating ______________

Operation ______________________ Rater ________________

Department ______________________ Date ________________

Supervisor ______________________ Approved ________________

Remarks ____

____

CHAPTER V

DISCUSSION OF RESULTS

The completed Hazard Potential Rating Form was presented at the close of the preceding chapter. This form is used in much the same manner as is the job evaluation point rating sheet. After studying the operation, the rating individual would evaluate each hazard element as to its degree of accident potential. The time that should be spent in studying each operation beforehand is dependent upon the complexity of the operation being rated. However, it should be of sufficient duration so that all aspects of the task have been considered. If necessary, the workers and the supervisor can be queried as to any infrequent duties that may have been overlooked. The worker should also be asked to comment on the completed rating to determine if any important points have not been considered. The completed rating form should be reviewed and approved by a safety supervisor who has some knowledge of the operation under consideration. Finally, the rating and the operation should be reviewed at periodic intervals to determine if any situations have arisen that might indicate a re-evaluation is required.

Although any evaluation procedure is inherently subjective, this disadvantage can be greatly diminished through the use of the proper definitions for both the degree of hazard and the elements that are used. These definitions should be presented in as objective form as is possible. Actual weights, sizes and distances should be used in place of vague generalities whenever possible. The rating individual should be trained in using objective guidelines in making the evaluation. Eliminating the subjective element from any evaluation procedure is not feasible, however, its effect on the final result can be greatly controlled if the preceding points are considered in the development of the rating plan.

CHAPTER VI

RECOMMENDATIONS

The Hazard Potential Rating Form that was developed is not meant to be able to handle any and all situations. It was formulated using a restricted sample space as to both elements and data. In other situations it might be advisable to consider more hazard elements in the study. In another case, more degrees of each hazard might be preferred. The range of the adjusted overall severity rate that was used to determine the weighting factors might have to be altered. However, in all of these cases, the procedure used to develop the rating form would still remain the same as has been proposed.

The number of hazard elements used in the development of the proposed method was extremely limited. It is expected that the average industrial enterprise will have many more hazards with which to contend. As more hazards are added to the analysis, the possibility of confusion over terms and of overlap increases. The safety engineer is required to define the elements and degrees more specifically as the number of elements is increased. However, care must be taken to prevent these definitions from becoming so large that they result in a cumbersome and unwieldy system of words. The larger, and more complicated, that the definition becomes, the more training and experience is required of the rating individual.

Before implementing the rating system in any situation, it should first be tested to determine its reliability. Several operations can be selected at random and rated using the derived evaluation form. The ratings of this pilot study can then be compared with historical performance and personal evaluations to determine if the results are consistent with what actually occurs. It is recommended that a minimum of five operations be used to carry out this testing procedure. The testing study should be performed by the same raters who will be responsible for the accepted evaluation study, in order to determine if there is any need for further training on their parts.

APPENDIX

The following are the degree definitions that were chosen and used in the development of the proposed evaluation form.

	Max. Pts.
I. Handling Objects	
1. Manual	
a. Minimum of manual handling required of operation.	0
b. Infrequent handling outside line of normal duty.	5
c. Intermittent handling operations necessary to work progress.	10
d. Frequent manual movement of heavy or bulky loads.	15
e. Continuous movement of heavy or bulky material.	20
2. Mechanical	
a. Little contact with mechanical handling equipment.	0
b. Infrequent need of mechanical handling equipment.	5
c. Operates in area where mechanical equipment operates frequently.	10

		Max. Pts.
	d. Uses mechanical equipment frequently in course of operation.	15
	e. Continuous use of mechanical equipment.	20
II. Falls		
1. Same Level		
	a. Operates in open area with few obstructions and non-slip flooring.	0
	b. Operations in well organized area with normal flooring material.	2
	c. Works in cluttered area with clear aisles and normal flooring material.	4
	d. Cluttered working area with frequent movements required.	6
	e. Cluttered working area with frequent movements and slippery floor materials.	8
2. Different Level		
	a. Operates at ground level at all times.	0
	b. Infrequent need to ascend to elevated position.	3
	c. Operates at elevated level with adequate safeguards and infrequent moves.	6
	d. Frequent movement at elevated level with adequate safeguards.	9
	e. Operates frequently at elevated levels with few safeguards.	12

		Max. Pts.
III.	Struck by Falling Moving Object	
	a. Works in area where there is little danger from above.	0
	b. Works in area where small, light objects might fall at infrequent intervals.	4
	c. Small or medium size objects tend to fall at infrequent intervals.	8
	d. Small or medium objects fall at regular intervals.	12
	e. Large or heavy objects have possibility of falling at frequent intervals.	16
IV.	Danger from Moving Machinery	
	a. Operates in area containing no moving machine parts.	0
	b. Infrequent visits necessary to an area containing moving machine parts.	3
	c. Continuous indirect contact with moving machine parts.	6
	d. Direct contact incurred with moving machine parts.	9
	e. Operates machinery with exposed moving parts	12
V.	Bumping into Objects	
	a. Works in open area with no obstructions.	0
	b. Works in well organized area.	2
	c. Cluttered area with clear operating area.	4

		Max. Pts.
	d. Cluttered operating area with few movements required.	6
	e. Cluttered working area with frequent movement required.	8
VI.	Use of Hand Tools	
	a. Operation requires minimum contact with any hand tool.	0
	b. Operation requires use of simple hand tools at infrequent intervals.	1
	c. Operates simple hand tool as normal function of work.	2
	d. Operates complex hand tools at infrequent intervals.	3
	e. Operates complex hand tool(s) as normal part of job.	4
VII.	Danger from Electricity, Heat, or Explosive	
	a. Operates in clear area with minimum of exposure.	0
	b. Operates in area where small amount of exposure is present	3
	c. Operation requires frequent visits to high danger areas.	6
	d. Operates continuously in area where danger is present.	9

		Max. Pts.
	e. Operates in high danger area with inadequate safeguards.	8
IX.	Danger from Elevators, Hoists, or Conveyors	
	a. Minimal contact with each.	0
	b. Contact at infrequent intervals with guarded machinery.	1
	c. Frequent contact with adequately guarded machinery.	2
	d. Infrequent contact with unguarded moving parts	3
	e. Frequent contact with moving parts of unguarded machinery.	4

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